

2020-03

Reducing unintentional injuries in under fives: Development and testing of a mobile phone app

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<http://hdl.handle.net/10026.1/16036>

10.1111/cch.12729

Child: Care, Health and Development

Wiley

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**Reducing Unintentional Injuries in under Fives:
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Journal:	<i>Child: Care, Health & Development</i>
Manuscript ID	CCH-2019-0234.R1
Manuscript Type:	Research Article
Keywords:	Health Promotion, Injuries, app development, under fives, accident prevention, Parents

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Reducing Unintentional Injuries in under Fives: Development and Testing of a Mobile Phone App

Abstract

Background: Unintentional injuries are a leading cause of preventable death and a major cause of ill health and disability in children under five years of age. A health promotion mobile phone application, ‘Grow up Safely’, was developed to support parents and carers in reducing unintentional injuries in this population of children.

Methods: A prototype of the mobile application was developed to deliver health education on **unintentional injury** prevention linked to stages of child development. In order to explore the usability of the app and refine its content, three focus groups were conducted with 15 mothers. Data were analysed using thematic analysis.

Results: The majority of participants reported previous use of health apps, mainly related to pregnancy, and recommended by health professionals. The app was considered user-friendly and easy to navigate. Participants in two focus groups found the app informative, offered new information and they would consider using it. Participants in the ‘young mum’s’ group considered the advice to be ‘common sense’, but found the language too complex. All participants commented that further development of push-out notifications and endorsement by a reputable source would increase their engagement with the app.

Conclusion: The ‘Grow Up Safely’ mobile phone app, aimed at reducing unintentional injuries in children under five, was supported by mothers as a health promotion app. They would consider downloading it, particularly if recommended by a health professional or endorsed by a reputable organisation. Further development is planned with push-out notifications and wider feasibility testing to engage targeted groups, such as young mothers, fathers and other carers.

Key Messages

1. There is interest from mothers in using a mobile application that offers health promotion advice linked to the stages of child development.
2. Parents report that they are more motivated to download and use health apps that are recommended by health professionals.
3. Further development of the app needs to include the use of push-out notifications.
4. Wider feasibility testing needs to seek feedback from a range of potential users including fathers, other carers as well as professionals.

Introduction

Unintentional injuries, such as burns, scalds, falls and poisoning, are a leading cause of preventable death and a major cause of ill health and serious disability in children under five years of age (Kendrick et al., 2017). In England, around 50% of all unintentional injuries in this child population occur in the home (The Royal Society for the Prevention of Accidents, ROSPA, 2012); these injuries account for 8% of deaths in children aged one to four years (Public Health England, PHE, 2014).

Reducing unintentional injuries is a major public health issue and a significant area for health promotion for the early year's workforce (Department of Health, 2009, PHE, 2016). Recently published data has highlighted that every year in England, on average: 55 children under the age of five die due to an unintentional injury; 370,000 children attend accident and emergency (A & E); and 40,000 children are admitted to hospital as an emergency (PHE, 2018). The average annual cost of attendance at A & E for unintentional injuries in this age group is approximately £9 million and the cost of hospital admissions, depending on the type of injury, is estimated to be between £16–87 million (Davies, 2012). However, these statistics do not include the unknown number of injuries receiving care in other health care settings or in the home.

Children who live in the most deprived areas are 13 times more likely to die due to injury compared to those in the most affluent areas (Davies, 2012). Other factors including gender, age, culture, ethnicity and an inability to adapt and control the home environment can also increase children's risk of exposure to a potential hazard (Pearson et al., 2009, National Institute for Health and Care Excellence, NICE, 2010). The availability of safety equipment in the home is one concern, but also the knowledge and behaviour of parents and carers, including that of child development, has been indicated (PHE, 2018).

Although some parents are proactive in **unintentional injury** prevention, others only react once their child demonstrates behaviour which may increase the risk of **unintentional injuries** (Ablewhite et al., 2015). The majority of **unintentional injuries** occur in the presence of an adult, perhaps indicating that low parental supervision may also be an underlying factor, in addition to parents underestimating potential hazards (Tsoumakas et al., 2009). Overestimating potential hazards and limited knowledge of child development can inadvertently lead to inappropriate overprotection, this may impact on parents providing an environment that is stimulating enough to aid their child's development (Falleiros de Mello et al., 2014).

Education to reduce **unintentional injuries** is a priority, as unintentional injuries in and around the home are almost entirely preventable (Department of Health, 2013). Previous research has focussed on initiatives targeting one specific risk area, such as car safety, scald or poisoning prevention (Hubbard et al., 2015; Kendrick et al., 2008; Shenoi et al., 2010). Very few interventions have aimed to address **unintentional injury** prevention more widely. The main delivery mode of broader interventions is through education packages. Parenting education, including education about child development and home safety interventions have been found to be effective in reducing child injury (PHE, 2017, Kendrick et al., 2013, Gaines and

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Schwebel, 2009, NICE, 2010). There is a requirement for health education to be universally delivered, with targeted interventions linked to child development, centring on **unintentional injuries** with the highest prevalence and directed towards families most at risk (PHE, 2018, ROSPA, 2012). However, a challenge with education interventions is reaching a wide enough audience to make a significant impact on injury reduction, and offering support prior to initial injury. Mytton et al. (2014) developed an eight-week group-based parenting programme, to provide first aid and safety advice to parents of children under five years; these children had all sustained an injury in the previous year. Children were monitored for six months post-intervention. A reduction in injury rate was reported, demonstrating the feasibility of this intervention.

Technology provides a further vehicle to deliver health education messages. MHealth is the use of mobile and wireless technologies used to support the achievement of health objectives, such as health promotion (World Health Organisation, 2011). Over 318,000 health apps are now available worldwide, this is five times greater than in 2013, and over 200 health apps are added to app stores each day (IQVIA, 2017). Due to this large scale availability, links to other technologies and the ability to download updates; health apps have the potential to improve population health and wellbeing (Hebden et al., 2012). There are however limitations to their use; they can be expensive to develop and may not be accessed widely; 50% of health apps are downloaded less than 500 times (Birnbaum, 2015). One way to improve utilisation is to include end-users' feedback in the development of health apps (Schnall et al., 2016).

Mobile phone apps can contribute to bringing health care to underserved or unserved populations (García-Gómez et al., 2014). One of the most active health information seekers are women or couples who are having a baby, or have recently had a baby. Research by Waring et al. (2014) explored the use of mobile apps by pregnant women; 86% of the women surveyed were interested in pregnancy-related apps or websites. The majority stated that their use was most regularly via smartphone. Seventy-two percent of UK adults now use a smartphone, this is an increase of 10% from 2014 (Ofcom, 2017).

The project

The android mobile app 'Grow up Safely' (GUS), was developed to enhance parental knowledge and understanding of areas of potential injury risk. Information about how to prevent **unintentional injuries** is included alongside information on child development, enabling parents and carers to feel more confident and competent when caring for their young children. By providing parents with **unintentional injury** prevention strategies, related to the stage of their child's development, the app was intended to encourage parents to apply this knowledge in their everyday lives.

The overall project aims were to:

- 1. **Develop an app to offer parents/carers educational advice about unintentional injury prevention tailored to their child's developmental age.**

2. Increase parental knowledge and understanding of areas of potential danger and injury risk, unintentional injury prevention and child development.

To develop this prototype app, three project phases were undertaken:

Phase 1 **objective**: To identify and review existing literature and resources to inform the development of the app.

Phase 2 **objective**: To develop a prototype app.

Phase 3 **objective**: To explore the usability of the app, in terms of ease of use, usefulness and aesthetics from the perspective of parents.

To ensure that a credible, evidence-based application was developed with relevant content and user-friendly design, an app development group was established consisting of: the research team, partners from Public Health, the local Borough Council, Children's Centres, and NHS providers. This group were consulted throughout the project and maintained oversight of the development of the app.

PHASE 1: Scoping

For each of the three phases of work, the methods and results sections are presented together, beginning with Phase 1.

Methods

Relevant research databases, such as CINAHL, PsychInfo, EMBASE and Medline, were searched to identify current literature pertaining to unintentional injuries in under-fives. Search terms included: unintentional injuries, prevention, accidents, parents, risk. No limits were placed on year of publication. Studies were independently appraised by three members of the research team who had relevant experience in public health and unintentional injuries. Publications were included if they incorporated evidence about safety practices or safety education relating to reducing unintentional injuries in young children. All types of studies were included. Following discussion, appropriate evidence was assimilated to inform the app content. Websites and app stores were also searched.

Results

Literature highlighted the extent of this public health issue; the impact on children, families and the health economy. The review of websites and app stores showed that although unintentional injury prevention advice was available on the internet, no mobile apps existed that addressed prevention of unintentional injuries in relation to the stages of child development; a finding supported by a recent study listing 46 apps in the iTunes Store aimed at parents which deliver education regarding infant and child health with none focusing specifically on preventing unintentional injuries (Winders Davis et al., 2017). Our searches identified two app-based interventions, one is at protocol stage aimed at reducing hot drink scalds (Burgess et al., 2016) and the other is aimed at child passenger safety (Gielen et al., 2015). No apps were identified that deliver information on common and serious types of injuries, aimed at

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developmental stages and behavioural habits common to children under five years of age.

Our review highlighted a gap for the development of Grow up Safely. We concluded that the app would address priority areas of **unintentional injury** prevention highlighted by PHE, the Child Accident Prevention Trust and the Royal Society for the Prevention of Accidents (PHE, 2018). Our aim was to tailor the app to high-impact areas in our local population; these include falls from furniture, poisoning from medicines, hot-water scalds and choking (Surrey County Council, 2014). The app would offer educational advice tailored to the child’s developmental age with the aim of increasing parental knowledge of **unintentional injury** prevention. Links to first-aid related websites would be included. It was also considered important to feature information on play that supports child development as research has suggested **unintentional injury** prevention advice can make parent’s risk adverse, preventing them from offering their children opportunities to engage in risky play that may aid their development (Brussoni et al., 2012).

PHASE 2: Prototype Development

Methods

Over a period of six months, the app development group met regularly, alongside a professional app developer, to develop the app content and design.

This period included public involvement activity - we sought the opinions of service users at a local Children’s Centre. We discussed the concept of the app with parents and carers at a parent and toddler ‘Stay and Play Group’. Participants were asked: whether they would be interested in using a health education app to support the reduction of unintentional injuries, whether the areas of **unintentional injury** prevention included met their needs, whether safety information relating to children’s developmental stages was useful and their views on the suggested app names.

Results

The consultation with service users indicated that they would consider using an app to support the reduction of unintentional injuries, the areas of unintentional injury prevention proposed met their needs and they would find safety information relating to developmental stages useful. ‘Grow Up Safely’ was selected as the preferred app name.

Feedback from service users was incorporated into the prototype mobile phone app. This prototype included:

- **Unintentional injury** prevention advice linked to priority areas for reducing unintentional injuries in children under five years.
- Information structured according to developmental stage (0-3 months, 3-6 months, 6- 9 months, 9-12 months, 1 year-18 months, 18 months-2 years, 2-3 years, 3-4 years, 4-5 years).
- Information on child development and danger awareness at each stage.
- Safe play tips to support child development.

- Web links to first aid websites.

This information was accessed by entering a topic into the search bar or by adding a child's details (name and date of birth); thus parents could get tailored, age appropriate information on how to reduce **unintentional injuries** for their child(ren).

PHASE 3: Feedback on the prototype

Method

Three focus groups were conducted at a local Children's Centre to gather multiple perspectives of the app in an interactive group setting. **The Children's Centre supports local families with children aged 0-5 years old in getting the best start in life. The Children's Centre team offers support and advice on parenting issues, child development, education and play through one-to-one and group sessions. The centre is located within a deprived neighbourhood; the 2015 Indices of Deprivation indicate the rate of child poverty is 22.3% in that ward (area), which is greater than the average for England, 19.9% (Data from: <http://www.localhealth.org.uk/#v=map15;l=en>). The ward also has a population rate of under-fives at 8.4%, which is greater than the England average of 6.3% (Data from: <http://www.localhealth.org.uk/#v=map15;l=en>).**

Participants were recruited via a poster advertisement at the Children's Centre. **The poster indicated any parent/carer of a child(ren) under five years old could participate.** An invitation letter and information sheet was sent to interested potential participants, communicating the aim of the focus groups, dates and times. The same two members of the research team facilitated all three groups (SA, FJ). At the start of each group, the researchers introduced themselves and explained the aims of the focus group and project as well as the nature of confidentiality and how the participants' data (quotes) would be used. The participants had the opportunity to ask questions about the project prior to signing a consent form. Questions/prompts for the groups were developed from the literature (Box 1). **One facilitator with prior experience of conducting focus groups took the lead on asking the questions.**

Three focus groups took place at the same time as regular weekly parent/carer and child groups in the Children's Centre. These groups were: 'pre-crawler' group (for parents/carers of young babies who are not yet crawling), young parent's group (for parents aged 23 years and under) and a parent and toddler group. In total, 15 mothers participated in three groups: six from the young mums' group, four from the 'pre-crawler' group and five from the toddler group (mothers in the latter group all had more than one child). The groups were small but diverse. A crèche was provided by the Children's Centre staff during the young parent's group and parent and toddler group. The parents attending the pre-crawlers group had their babies with them during the focus group. Each focus group lasted around an hour, including time for participants to familiarise themselves with the app. The researchers met after each group to discuss the broad themes emerging, after the third group they felt data saturation had been reached. The focus groups were audio-recorded and transcribed verbatim. The transcriptions were analysed by the researchers who had facilitated the groups using thematic analysis (**Coffey and Atkinson, 1996**). Analysis

focused upon strengths and inadequacies of the app along with recommendations for improvements. The researchers read the transcripts independently to familiarise themselves with the data. Relevant comments were highlighted within the text and annotations written in the margins. Highlighted comments (or summaries of comments) were grouped into topics **to create categories containing data that shared some common elements. The two researchers met to discuss and refine the categories and generate themes.** Agreement and understanding of themes was gauged during discussions until consensus was reached: there were in fact few discrepancies.

Results

Seven themes were identified: app name and logo; layout of the app; health information; use of pictures on the app; previous use of health apps; usability of GUS; engagement with the app.

App name and logo

All participants liked the name 'Grow Up Safely' (GUS), feeling that it was appropriate and stated clearly what the app was about. The penguin and baby logo was also felt to be appropriate, with one participant mentioning that it was good as it was gender neutral, appealing to fathers and grandparents (Figure 1).

'Yes, it's good because it's not too specific about gender because some things are really like mum and baby, and obviously... I always think it's bad.' (Mother from Pre-crawler group)

Layout of the app

The app was described as user-friendly and easy to navigate through the topic sections (Figure 2). Feedback was positive about the ability to tailor the information to a specific child (Figure 3). Participants found it easy to add in a child's details (Figure 4) and liked how the information then related to age specific **unintentional injury** prevention advice for that child. They also felt that the stages of development were structured into the right age groups.

'But I thought it flowed nicely; I think it is good that it is broken down. Because you could do all of drowning issues for every age group, but actually it is just so much more to read. It is good if you can just get it for your child's age.' (Mother from toddler group)

Health information

The majority of participants felt that the information included on the app was well written, informative and had the right level of information. Two of the groups commented that the information was succinct and easy to read, with one participant stating it was:

'Very well written, I thought. Easy to read and interesting.' (Mother from pre-crawler group)

Another commented:

'I didn't know how dangerous button batteries were until recently. So there is lots of it that comes down to common sense, but it is almost letting people know that there are things that can happen that you don't even know about' (Mother from toddler group)

However, some of the participants in the 'young mums group' felt the language was 'too posh' and verbose which put some of them off trying to read it. One participant mentioned that she had dyslexia and for her the content was difficult to read as it was too long and complex:

'I'll be honest with you, I just looked at the word straight away and I was like I can't read that, I'm not going to even try'. (Mother from young mum's group)

The participants also felt that the links to external sources of health information, such as what to do if your child is choking, supported their learning. They thought further links to video clips would be helpful.

Use of pictures on the app

These were perceived as mostly appropriate, relevant and bright, although some pictures, such as those in the burns and **scalds** and drowning sections felt unconnected to the topic area. However, the participants commented that it might be difficult to add more appropriate pictures as they did not want to see distressing pictures as this would distract from the content. As most of the pictures were relevant, this made it easier for participants to find the different topics, particularly if a smaller screen was being used.

'The pictures of the different topics make it a lot easier to see what you are looking for.....I could not see the words because I have a small screen.' (Mother from young mum's group)

Previous use of health apps

The majority of participants had used health apps in the past with many using apps that gave pregnancy advice. Some had also used apps relating to breast feeding. Health professionals such as doctors, midwives and health visitors had recommended many of these apps. The participants felt that they would be more likely to use the app if it had been recommended by a trusted source such as a health visitor or midwife. In order to add credibility, the participants also suggested that the app needed links to a reputable source, for example the NHS, or another well-known organisation/charity:

'So I suppose if it was given to me by a health visitor, for example, that would be like a rubber stamp that it was something official and proper, whereas if it was just something I saw advertised on a website/chatroom I would probably be as wary of that as I would be of any other information.' (Mother from toddler group)

Usability of the GUS app

Participants in two of the focus groups liked the idea of the app and felt it was something they would use. They said that they had not seen an app like it before and

that it filled a gap in the information they had previously received. One participant commented:

'I think a lot of it is common sense a lot of the time, but when you are sleep deprived and your child is moving milestones constantly, you are not always thinking with a clear head, and actually having something that is going to remind you, "Oh, I need to start moving back, you know, further away, or change where I plug this in," or whatever, it wouldn't be a bad thing.' (Mum from toddler group)

Another commented:

'I think it's a great idea. Really good app. If there's a lot of awareness out there that this service is available then people will certainly – with children – look into that information. I think it's a great idea' (Mother from pre-crawler group)

The focus group with the young mums felt that the information was 'common sense' and not something they would read through unless they needed to check information. As the group reviewed the content they highlighted safety advice that they had not considered, for example regarding Halloween/Christmas and pond safety,

'There's Halloween safety on there. Not many people think about safety at Halloween, do they?..... Christmas safety as well. Being near ponds and lakes.'

There was some confusion within all groups about the purpose of the app, it just being focused on **unintentional injury** prevention. There were many suggestions about adding information on first aid and childhood illnesses. They felt more links to first aid websites would be useful.

Engagement with the app

To develop their engagement with the app further, all the groups felt that the app needed to send out regular push-out notifications which would be most helpful if linked to the age of the child. One participant related the app to another health app they used:

'If it were trickle fed to me information at an appropriate time and it was something that I checked every day in the same way that people check Facebook intermittently and check other things. One of the things that I check is the Bounty app and I know I do that once a day because I get a new thing each day'. (Mother from pre-crawler group)

Discussion

This early development work involving reviewing the literature and seeking the perceptions of parents has been imperative in guiding the development of the GUS app to ensure that the content is relevant and useful to end users. The concept of a health education app to reduce unintentional injuries in under-fives was generally well received by parents. They confirmed that there was a gap in the app market for this type of health information and education app for parents and carers. This is

important as health professionals, such as health visitors, need to consider ways that new digital technologies can extend the reach of health education they can provide (Local Government Association, 2017). The name of the app, logo and design, including the need to tailor information to a child's age, were all perceived positively by the participants. This feedback was encouraging as research has shown that apps which have a simple interface, with user-friendly design can be used without training to improve retention/use (Zhao, Freeman and Li, 2016).

One of the objectives of the current study was to explore the usability of the app with parents. The majority of participants felt that the content, including use of images, language, information given and links to external websites were user-friendly. The response from the young mum's group was not as positive. This group felt some of the language used was complex and there was too much information. Dennison et al. (2013) found that young people tend to have little patience with health apps that are time consuming and have lengthy content, easily discarding apps that do not meet their expectations; this is of concern as research shows that lower maternal age increases the risk of child unintentional injuries (Orton et al., 2012, Shah et al., 2013). Further thoughts on how to design the app to engage this group of parents is an important area to consider.

The app was developed to offer parents/carers educational advice about unintentional injury prevention to increase their knowledge and understanding of areas of potential danger and injury risk. Reading the content of the app, many mothers highlighted areas of safety information that they were unaware of. Further links to websites and visual sources such as video links have been shown to support the delivery of health education to those with lower levels health literacy (Kim and Xie, 2017), this was identified by participants as something that would be useful to support their learning.

Suggestions to improve the usability of the app were made. Participants highlighted that push-out notifications would increase engagement and sustainability of use with the app. The GUS app does not have this facility currently. Push-out notifications sent at regular intervals have been shown to increase engagement with health apps in the short term (Anderson, Burford and Emmerton, 2016, Freyne et al., 2017) but they need to be relevant and timely, otherwise they may negatively impact on the overall usability of the app (Dennison et al., 2013). The potential impact of these notifications on the usability versus the cost of development will need to be carefully considered in future refinement of the app.

Most of the focus group participants who stated that they had used health education apps in pregnancy, had been introduced to them by their midwife or another health professional. Recommendation of a health app by a health professional appeared to be a significant factor in whether parents would download the app. This is supported by findings from IMS Institute for Healthcare Informatics (2015) which highlighted an increase of over 10% in the amount of users using a health app for 30 days if the app was recommended by a healthcare professional. Ways to engage local health professionals to support the app being downloaded and used by parents will be an important element of further development. Reflections from projects, such as 'baby

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buddy', which used embedding techniques to support health professionals to advocate and empower parents to increase their use of m-health technology will need to be explored further (Crossland, Thomson & Hall Moran, 2017).

With many health apps available for download, app designers need to ensure that the content is evidence-based in order to increase consumer trust in health apps. The NHS have developed a digital app library, to help the public identify credible and trustworthy apps (Bauer and Murphy, 2017). The focus group participants indicated that they would be more likely to download GUS if it was linked to a reputable source. This concern aligns with findings from Dennison et al. (2013), where apps were considered more preferable and credible if they were developed by a known, reliable source. Consumers want health apps that are trustworthy, have accurate data, are simply designed and are easy to use (Deloitte Centre for Health Solutions, 2015).

Limitations

The generalisability of our findings is limited as, although the participants were from a diverse group of mothers, they were small in number and self-selected from one geographical area. As the focus groups only included mothers, any future feasibility testing will need to seek feedback from fathers, other carers such as grandparents as well as from relevant professionals.

Conclusion

We describe the development of a public health intervention prototype app designed to deliver health education to parents/carers on unintentional injury prevention. Our engagement with mothers indicated they are interested in using a mobile app that offers health promotion advice linked to the stages of child development. During usability testing, mothers indicated that they would consider downloading the GUS app, particularly if recommended by a health professional or endorsed by a reputable organisation. The app was considered user-friendly and easy to navigate. Suggestions for refinements to increase engagement with the app were made, such as the inclusion of push-out notifications and simplifying the language. This feedback gathered from participants will assist us in refining the contents of the app prior to further testing. Wider feasibility testing needs to seek feedback from a range of potential users including fathers, other carers as well as professionals. Further research also needs to be undertaken on whether the app impacts on parent's knowledge and behaviour in relation to age appropriate unintentional injury prevention strategies as this is the unique focus of the app.

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Review Copy

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3 **Box 1 Focus group topic guide**
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6
7 **Welcome**

- 8
 - Introduction.
 - Purpose of focus group and guidelines for the session.

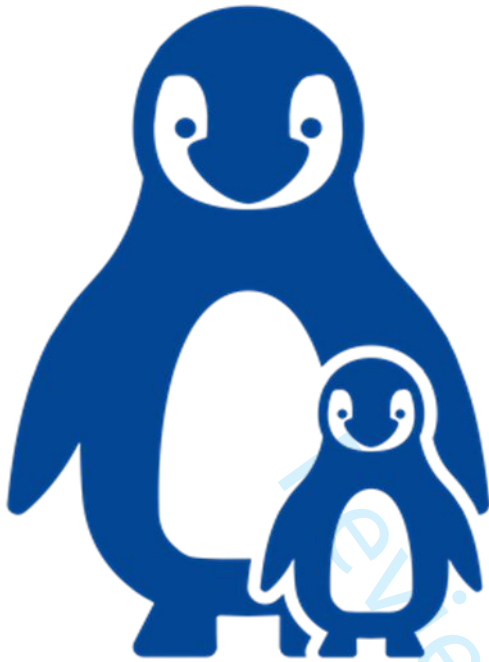
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12 **Questions**

- 13
14 1. What is your experience of using mobile phone apps?
15 2. How do you feel about using a mobile phone app that is aimed at
16 reducing unintentional injuries in children under five years old?
17 3. What do you think about the overall layout and appearance of the app?
18 4. The app covers a variety of topic areas linked to different stages in a
19 child's development; do you find the areas covered helpful?
20

21 The topic areas are:

- 22
 - Developmental stages
 - Danger awareness
 - Play tips
 - Choking
 - Suffocation and strangulation
 - Falls
 - Poisoning and ingestion
 - Burns and scalds
 - Drowning
 - House fires
 - Glass related injuries
 - Road safety
 - Age specific accident advice
 - Seasonal accident advice
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41
- 42 5. When looking at a topic, how informative do you find the content?
43 6. Is the topic information clearly written?
44 7. What do you think of the images we have used in the app?
45 8. What are your thoughts on the app name?
46 9. Have you any other thoughts about the app?
47
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Figure 1 Grow Up Safely Logo



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3 Figure 2 Searching for a Safety Topic
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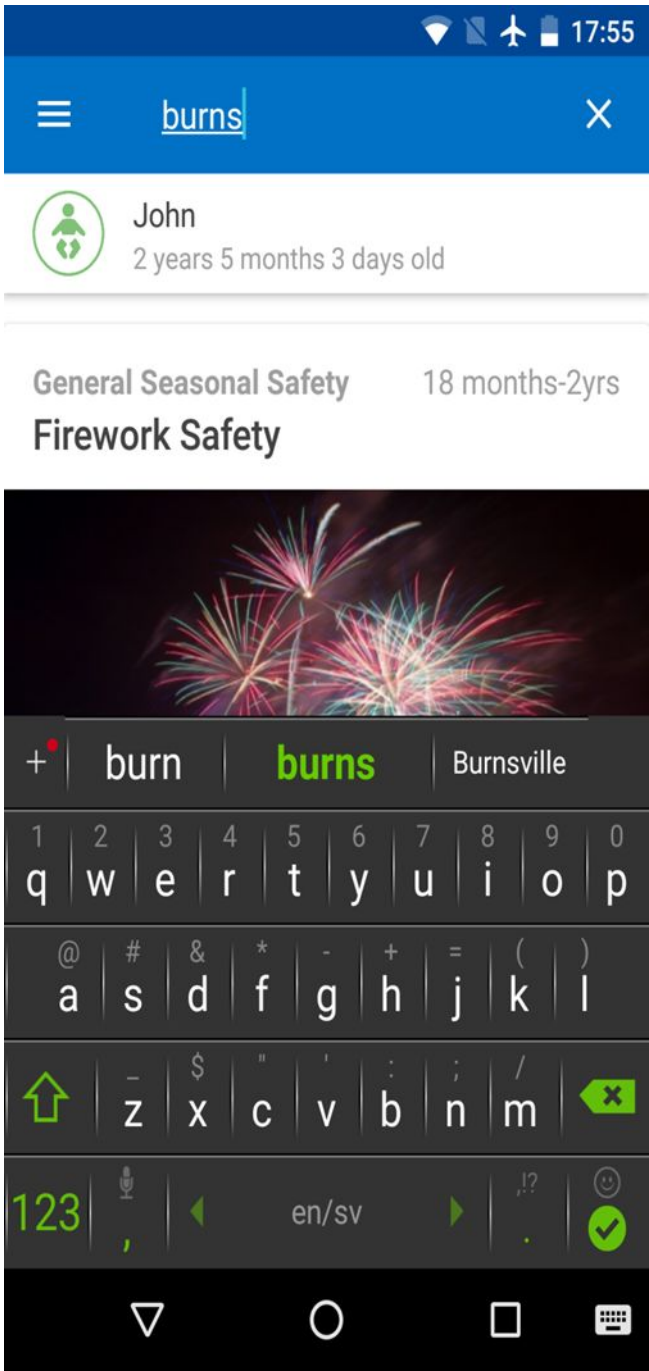
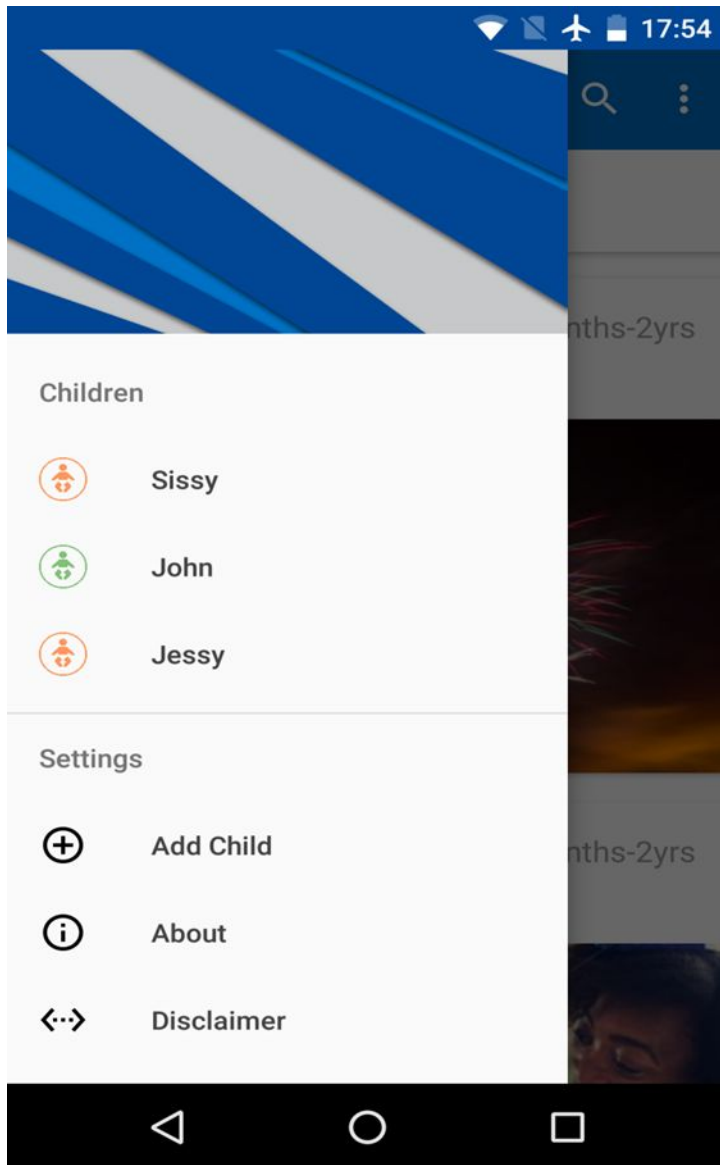


Figure 3 Search by child's name



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Figure 4 – Adding a child to the app

